

## VTT Technical Research Centre of Finland

### The 1st MycoKey technological workshop

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The 1<sup>st</sup> MycoKey technological workshop

# Integrated preventive actions to avoid mycotoxins in malting and brewing



MAY 23-24, 2018

Finlandia Hall, Helsinki, Finland

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Arja Laitila, Päivi Vahala and Tuija Sarlin

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Railway station: Sakke Sonerma, Visit Helsinki

Barley field: Arja Laitila, VTT

# The 1<sup>st</sup> MycoKey Technological Workshop

Integrated preventive actions to avoid mycotoxins in malting and brewing

May 23-24, 2018

Helsinki, Finland

This workshop is organized within the framework of the Horizon 2020 -Research and Innovation Action - Societal Challenge 2 - " Food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bioeconomy challenge"- GA 678781 MycoKey " Integrated and innovative key actions for mycotoxin management in the food and feed chain"



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## Introduction

Contamination of cereals by various toxigenic fungi is a serious global concern. The Food and Agriculture Organization of the United Nations (FAO) has estimated that 25% of the world's crops are affected by mycotoxins (each year) and the estimated annual losses extend to billions of dollars. It is obvious that contamination of brewing raw materials with toxigenic fungi cannot be completely avoided, especially in crop years with bad weather conditions. Recognising, understanding, and managing toxigenic fungi and mycotoxin production require close cooperation and communication between different stake holders along the food, beverage and feed production chain.

In the Helsinki workshop, we will focus on the malting and beverage industry. However, the challenges are common to many grain processing sectors. This workshop aims to bring together industrial representatives, government agencies, researchers, scientists, technologists and provide them a unique international platform for sharing new ideas and novel approaches in mycotoxin management. Finland is one of the technology leaders in Europe and its capital Helsinki is recognised as a city in which many differing views can interact in a constructive atmosphere. Therefore, this city is an ideal location for an interactive mycotoxin workshop in which science meets practice and concerns related to recent advances can be openly shared.

Take time before and after the sessions as well as during the networking event to meet colleagues from around the world and to make new friends.

Enjoy your time in Helsinki!

On behalf of the local organising committee,



*Arja Laitila*

MycoKey partner and Principal Investigator  
at VTT Technical Research Centre of Finland Ltd





## Welcome from MycoKey

"Integrated and innovative key actions for mycotoxin management in food and feed chain"- MycoKey (<http://www.mycok ey.eu/>) is an European Commission funded (5 M euro) project under the Horizon 2020 program. It aims at developing smart, integrated, sustainable solutions and innovative tool kits to reduce the major mycotoxins in economically important food and feed chains, including malting and brewing chains. MycoKey is providing scientifically sound, concrete, timely and cost-effective measures to producers, processing industry and markets to minimize mycotoxin contamination along the chain. On going studies are investigating new methods to a) prevent mycotoxin contamination in the field, b) give solutions for intervention to be applied during/after fungal infection of crops/commodities and c) apply remediation tools for mycotoxin contamination reduction in post-harvest. Thirty-two partners from Europe, China, Nigeria, Argentina, including research institutions, SMEs, industries and associations are working together for four years, focusing on the main EU regulated mycotoxins including deoxynivalenol, zearalenone, ochratoxin A and fumonisins.

### *Welcome from the Organising Committee*

It is with great pleasure that we warmly welcome you to attend the 1st MycoKey technological Workshop on "Integrated prevention actions to avoid mycotoxins in malting and brewing" held in Helsinki from 23 to 24 May, 2018.

This Technological Workshop provides a unique opportunity for participants from all over the world to meet and discuss the issues on mycotoxin management along malting and brewing chain. The Workshop provides a forum for exchange of ideas and authoritative views by leading scientists as well as industry leaders and investors in this strategic and important field.

On the behalf of the Organizing Committee we would like to wish you an interesting/enjoyable Workshop and a wonderful stay in Helsinki, which is rich in history, tradition as well as of modernity and development. Please take the opportunity to meet old friends and make new ones.



*Antonio F. Logrieco*

MycoKey Coordinator







# Welcome to Helsinki

Helsinki is the capital and largest city of Finland. Helsinki alongside its neighbouring municipalities of Espoo, Vantaa and Kauniainen form a metropolitan area of more than a million inhabitants. Helsinki is a precious jewel of Baltic Sea and can be conveniently reached with direct flights from most of the European cities.



More information:  
<http://www.visithelsinki.fi/en>



In 2014, Helsinki was awarded City of Design status as part of the Creative Cities Network established by UNESCO. Our workshop venue, Finlandia Hall, is a masterpiece by the world-renowned Finnish architect, Alvar Aalto. It is located in the centre of Helsinki. ([www.finlandiatalo.fi/en](http://www.finlandiatalo.fi/en)).

Sitting on the edge of the Baltic, the modern, cosmopolitan city of Helsinki was the World Design Capital for 2012. The beauty of the surrounding nature blends seamlessly with high-tech achievements and contemporary trends. Walking tours of the city center show layers of history, while modern architecture and cutting-edge style stake the city's claim to the future. Helsinki during its endless summer days is a refreshing experience.

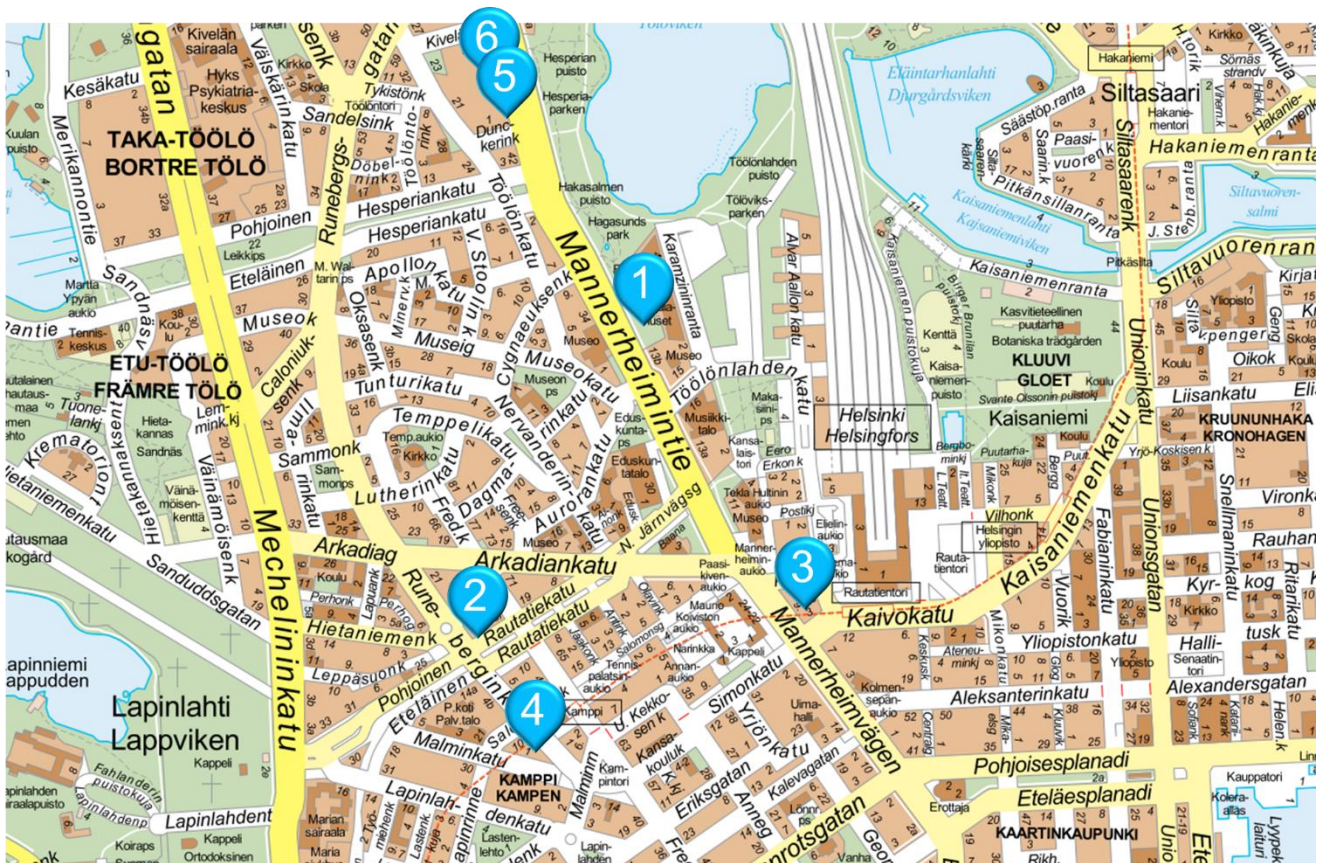






May is a splendid time of the year to visit Helsinki. The midnight sun allows us to continue discussions outdoors until dawn and over - be ready for an intensive 60 hour package. In the Helsinki city you can find places to listen the sound of silence, for example in the fortress of Suomenlinna - not typical for all capitals in Europe. Helsinki offers a wide variety of attractions to explore: the Market Square with its seagulls, the Esplanade Park with the beautiful Kappeli restaurant building and the

option for a lawn picnic, wonderful well-preserved architecture and historic monuments, design, delicious traditional food, and great natural sightseeing opportunities in the Finnish archipelago.



1. Finlandia Hall (Mannerheimintie 13e)
2. Hotel Helka (Pohjoinen Rautatiekatu 23)
3. Original Sokos Hotel Vaakuna (Asema-aukio 2)

4. Radisson Blu Royal Hotel (Runeberginkatu 2)
5. Scandic Park Helsinki (Mannerheimintie 46)
6. Crowne Plaza Helsinki 8 Mannerheimintie 50)

Thank you to the following MycoKey workshop sponsors:



*Elintarvikkeiden Tutkimussäätiö*  
*Finnish Food Research Foundation*

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Oy Panimolaboratorio -  
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Brewing Laboratory Ltd



## VTT Technical Research Centre of Finland Ltd

VTT Technical Research Centre of Finland Ltd is one of Europe's leading research, development and innovation organisations. We help our customers and society to grow and renew through applied research. The business sector and society in general benefit most from VTT when we solve challenges requiring world-class know-how together, and convert them into business opportunities. We have 75 years' experience supporting our clients growth with top-level research and science-based results. We develop new smart technologies, profitable solutions and innovation services.

VTT ensures efficient utilisation of science and technology with the aid of broad international cooperation and networking. VTT is part of Finland's innovation system and operates under the mandate of the Ministry of Employment and the Economy.

[www.vttresearch.com](http://www.vttresearch.com)



## Finnish Food Research Foundation

The objective of the Finnish Food Research Foundation established by the Finnish Food and Drink Industries' Federation in the year 1960 is to promote research and training to serve the Finnish food and drink industry.

The foundation supports postgraduate studies of young university students and internationalization as well as the directing of research to targets that are interesting for the industry.

Furthermore, the foundation funds projects the objective of which is to find new knowledge or area of utilisation.

[www.etl.fi/en/etl/research-foundation.html](http://www.etl.fi/en/etl/research-foundation.html)

*Elintarvikkeiden Tutkimussäätiö*  
*Finnish Food Research Foundation*

## XEMA Group

- Immunoassay company with 25 years of experience
- Antibodies and immunoassays for fungal antigens
- *Fusarium* spp ELISA kit for screening of cereals and soil
- Wide coverage of toxigenic species
- Determination of risk of mycotoxin generation

[www.xema-medica.com/eng](http://www.xema-medica.com/eng)





## PBL Brewing Laboratory Ltd

PBL Brewing Laboratory is a company devoted to pre-competitive research and development in malting, brewing and beverages. It is owned by one malt-producing company, Polttimo Oy, and four breweries, Oy Hartwall Ab, Oy Sinebrychoff Ab, Olvi Oyj and Laitilan Wirvoitusjuomatehdas. VTT Technical Research Centre of Finland Ltd is the main strategic research partner.

The objective of PBL is to build a scientific and technical platform for creating an environment promoting the shareholders' competence and global competitive edge in both the short and long term. PBL finances research projects that cover the whole value chain from barley to beer and coordinates technical scale trials and acceptance of new malting barley varieties in Finland.

[www.pbl.fi](http://www.pbl.fi)

# PBL



Oy Panimolaboratorio -  
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## MycoKey scientific committee

- Giuseppina Avantaggiato, Research National Council, ISPA, Bari, Italy
- Paola Battilani, Università Cattolica del Sacro Cuore, Piacenza, Italy
- Nunzia M. Cito Research National Council, ISPA, Bari, Italy
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- Cees Waalwijk, Stichting Dienst Landbouwkunding Onderzoek –DLO Wageningen, The Netherlands

## Organizing committee

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- Elina Sohlberg
- Jaana Uusitalo
- Päivi Vahala
- Kiira Vuoristo



# Programme

## Wednesday the 23th of May

### I Session (Chair Antonio Logrieco, CNR-ISPA, Italy)

- |             |  |
|-------------|--|
| 08:00-09:00 | Registration and coffee  |
| 09:00-09:15 | Welcome and introduction<br><i>ExcVP Jussi Manninen, VTT</i>   |
| 09:15-09:45 | Toxigenic fungi in malting and brewing - overview<br><i>Dr. Arja Laitila, VTT</i>  |
| 09:45-10:15 | Are we regulating the right topics in EU<br>- what are the bottlenecks in analytics today<br><i>Dr. Marika Jestoi, Evira</i> |
| 10:15-10:45 | Coffee break   |
| 10:45-11:15 | Advanced and representative sampling for mycotoxin<br>- the most critical steps<br><i>Mareike Reichel, Eurofins</i>          |
| 11:15-11:45 | Rapid and reliable tools for on-site detection and monitoring<br>of toxigenic fungi<br><i>Dr. Theo van der Lee, WUR</i>      |
| 11:45-12:15 | Recent developments in (multi)mycotoxin rapid screening methods<br><i>Prof. Sarah de Saeger, UGENT</i>                       |

12:15-13:15 Lunch

### II Session (Chair Irina Bolat, Boortmalt, Belgium)

- |             |   |
|-------------|---|
| 13:15-14:15 | The MycoKey app: an ICT solution to facilitate mitigation of<br>mycotoxin risks<br><i>Dr. Theo van der Lee, WUR</i>               |
| 14:15-14:45 | Coffee break  |
| 14:45-15:15 | Cropping factors: the key for suitable mycotoxin management in cereals<br><i>Dr. Susanne Vogelgsang, Agroscope</i>                |
| 15:15-15:45 | Effectiveness of fungicides against <i>Aspergillus flavus</i> and <i>Fusarium</i> species<br><i>Dr. Antonio Moretti, CNR-ISPA</i> |
| 15:45-16:15 | New intervention concepts to avoid storage fungi<br><i>Prof. Giuseppe Meca, UVEG</i>  |
| 16:15-18:15 | Networking cocktails with tasting plate of seasonal delicacies  |

## Thursday the 24th of May

### III Session (Chair Susanne Vogelgsang, Agroscope, Switzerland)

- 09:00-09:30 Combined intervention strategies to avoid toxigenic fungi  
– a maltsters perspective  
*Tom Bryan, Boortmalt*
- 09:30-10:00 Advanced grain cleaning solutions for mycotoxin reduction  
*Dr. Katarina Slettengren, Bühler AG*
- 10:00-10:30 Safe use options of contaminated batches in the metagenomics era  
*Dr. Massimo Ferrara, CNR-ISPA*

10:30-11:00 Coffee break

### IV Session Interactive panel discussion (Moderators Max Schulman MTK, Copa-Cogeca and Arja Laitila, VTT)

- 11:00-12:30 Science meets Practice: joint effort to fight against mycotoxins  
– is it possible and what are the critical steps?

12:30-13:30 Lunch

### V Session (Chair Giuseppe Meca, University of Valencia, Spain)

- 13:30-14:00 Early process design – how to integrate new actions in practice  
(modelling and challenges)  
*Dr. Eemeli Hytönen, VTT*
- 14:00-14:30 Integrated and innovative MycoKey actions for *Fusarium* mycotoxin  
management in the malting and brewing chain  
*Dr. Antonio Logrieco, CNR-ISPA*
- 14:30-15:00 Wrap up and future outlook  
*Dr. Antonio Logrieco, CNR-ISPA and Arja Laitila, VTT*
- 14:15-14:45 Coffee and networking

Session I

Chair Antonio Logrieco,  
CNR-ISPA, Italy





# Toxigenic fungi in malting and brewing -an overview

Arja Laitila

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Malted barley and wheat provides the basis of most beers in the world. Filamentous fungi (moulds) and their metabolites associated with cereal grain greatly influence plant health as well as malt and beer quality and safety (Table 1). The fungal community characteristic of grain develop in the field, under storage and during processing. Those that are capable of producing mycotoxins are a natural part of cereal ecosystems. Geographic location has been identified as the main factor determining the fungal communities associated with seeds. In addition, agricultural practices, storage, transport and processing influence the diversity and structure of the microbial community present in the brewing raw materials.

Table 1. Overview of reported negative impacts of filamentous fungi associated with barley /wheat and malt during storage and processing (Laitila 2015)

Quality reduction	Process failures	Health hazards
plant diseases	spontaneous heating of grain batch in silos	allergens
qualitative and quantitative changes in grain carbohydrates, proteins, lipids	reduced grain germination	mycotoxins
off-odors and -flavours	factors inducing premature yeast flocculation (PYF)	
discolouration of kernels	production of gushing inducers (beer overfoaming)	

The filamentous fungi have traditionally been divided into two rather distinct ecological groups: field and storage fungi. Field fungi invade the kernels while the plant is growing or during the harvest. *Alternaria*, *Cladosporium* and *Fusarium* fungi are the most common and widespread field fungi. These fungi require relatively high water availability for growth ( $a_w > 0.85$ , moisture content  $>18\%$ ). Thus, their growth is restricted during storage by appropriate drying of barley and wheat. However, dormant spores can survive in normal storage conditions for years. The fungal community changes during the storage depending on the initial microbiota, storage time and environmental conditions. Xerophilic *Aspergillus*, *Eurotium* and *Penicillium* are the most characteristic fungi found in the storage environment. Storage fungi are able to grow on kernels of moisture content as low as 13-15% ( $a_w \sim 0.70$ ). It must be noted that this differentiation into field and storage fungi is applicable only in temperate climate, since in warmer regions mycotoxin producing *Aspergillus* fungi have been detected in the developing barley and wheat in field. *Fusarium* fungi are considered as perhaps the most important group

of filamentous fungi with respect to malt and beer quality. The species of *Fusarium* are adapted to different ecological niches all over the world as saprophytes and plant pathogens with a wide range of host plants. Furthermore, the malting environment is favourable for *Fusarium* fungi.

This presentation will provide an overview on evolution and impacts of mycotoxin-producing fungi in malting and brewing. It then highlights the most important mycotoxins and their production in the beer production chain in order to identify the critical stages.

*Reference:*

Laitila, A. 2015. Toxigenic fungi and mycotoxins in barley-to-beer chain. In Hill, A (ed) Brewing microbiology. Managing microbes, ensuring quality and valorising waste. Woodhead Publishing Ltd, Cambridge, UK, 105-139.

# Are we regulating the right topics in EU? What are the bottlenecks in analytics today?

Marika Jestoi

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The basis for the regulations on food contaminants rely on high consumer protection. The exposure to contaminants must be kept in toxicologically acceptable levels, taking into account also the ALARA-principle. According to the legislation risk analysis approach, including a sound scientific risk assessment, must be applied in decision making.

Commission Regulation (EC) No 1881/2006 lays down maximum levels for certain food contaminants, including mycotoxins. In case maximum levels are exceeded, food cannot be placed on the market, and dilution, mixing or detoxification of contaminated material is forbidden. Today, maximum levels have been set for several mycotoxins, including aflatoxins, ochratoxin A, patulin, deoxynivalenol, zearalenone, fumonisins and citrinin. In addition, maximum levels are set for ergot sclerotia. Although there are also other known mycotoxins, we can conclude that - at least based on the current knowledge - all relevant mycotoxins are currently covered by the legislation. However, it has been recognized that more data on occurrence and/or toxicity is needed for some other mycotoxins to enable a reliable risk assessment, and furthermore the discussion on possible risk management measures such as setting maximum levels. For these purposes, recommendations for monitoring have been published e.g. for HT2/T2-toxins and ergot alkaloids.

As the legislation covers several matrix-mycotoxin combinations, their analysis can be time-consuming and expensive. Therefore, cost-effective and reliable methods with preferably multi-target properties are certainly needed. For official control these challenges are at present mostly solved by using LC-MS technique, still capable of qualifying the performance criteria of the legislation. However, considering the self-control of food business operators, these methods are not suitable as an everyday, routine tool. To provide instruments for practical risk management, rapid tests are needed. To obtain an effective approach, rapid tests should provide reliable results with preferably multiplexed properties. The food business operators are strongly encouraged to confirm the trueness of the rapid methods they use to avoid false negative (or positive) results resulting in food safety (or economical) problems.

## *Reference:*

Commision, E. C. 2006. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuff. 2006R1881-EN-01.09. 2014-014.001-1



# Advanced and representative sampling for mycotoxin - the most critical step

Mareike Reichel, Jan Sebastian Mänz and Scarlett Biselli

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On-site, mycotoxin measurements shall enable rapid decisions e.g. on the acceptance or rejection of lots. Hence, results have to be fast available, easy to get and, first of all, reliable. The reliability of measured mycotoxin contents depends on the uncertainties arising from all parts of the measurement process. Whereas the quality of rapid tests for on-site analyses has steadily improved within the last years, sampling remains the most critical step in the whole analytical chain. Especially for heterogeneously distributed storage mycotoxins, common sampling procedures are either not representative or, like the commission regulation (EC) 401/2006, ensure representativeness but are hardly applicable in terms of needed workforce and time.

An innovative approach using dust samples was developed and tested for mycotoxin analyses of food and feed bulk-ware. Small particles are abraded from the surface of grain or malt during every transport and handling step. Hence, these dusts arise from a huge number of kernels and can represent the whole lot better than a limited number of grain samples. A strong enhancement of mycotoxin contents on the small, surface particles compared to the bulk material was observed. Furthermore, dust generally contains minor levels of starch, proteins, and fats. Hence, the natural accumulation of mycotoxin in the dust and its limited matrix effects facilitate analyses of mycotoxins with rapid test systems even at low legal limits.

Data models were developed by analysing corresponding dust and bulk-ware samples. As the contamination of the overall sample and its dust particles correlated, contaminations in the bulk were calculable from concentrations determined in respective dust particles. Data models were set up for main *Fusarium* toxins in wheat and rye, as well as *Fusarium* toxins, aflatoxins and ochratoxin A in maize. First proof of concept tests were also performed with oat, barley, and malt.

In contrast to grain samples, no additional milling or homogenization step is needed for the dust. Instead, the sample can directly be extracted and analysed. The innovative high-throughput technology has the potential to improve on-site mycotoxin measurements in terms of speed, sensitivity, manageability and reliability and thus is a promising tool for enhanced industrial self-control.

## *Reference:*

Commission, E. C. 2006. Commission Regulation (EC) No 401/2006 of 23 February 2006 laying down the methods of sampling and analysis for the official control of the levels of mycotoxins in foodstuffs. 2006R0401-EN-13.03. 2010-001.001-1.



# Rapid and reliable tools for on-site detection and monitoring of toxigenic fungi

Theo van der Lee<sup>1</sup>, Iris Post<sup>1</sup>, Hao Zhang<sup>2</sup>, Anne van Diepeningen<sup>1</sup>  
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Mycotoxins are frequently contaminating cereal crops and can endanger human and animal health upon ingestion of contaminated food or feed. Trichothecenes are one of the most important family of mycotoxins and produced by several *Fusarium* species. Trichothecenes are regularly found in crops like maize, wheat and barley. Based on their chemical structure, trichothecenes can be divided into four classes, namely types A-D. Trichothecenes A and B are the most commonly found classes (WHO, 1990). Another group of important mycotoxins produced by *Fusarium* are the fumonisins. Fumonisins are mostly found in maize, rice and sorghum. The health hazards associated with these mycotoxins justify the generation of assays that make it is possible to detect the presence of *Fusarium* species that are able to produce Trichothecenes A and B and fumonisin. As these toxins can be produced by various *Fusarium* species, we designed the assays on the genes that are responsible for the mycotoxin production rather than on barcoding regions used for species identification. Various methods and tests have been developed, like PCR based assays (Demeke *et al.* 2005) or Luminex based assays to detect the presence of *Fusarium* species in crops. However, both require amplification of the target by polymerase chain reactions which is relatively time-consuming, and this technique requires a thermal cycler to be effective. Real Time PCR assays for detection of *Fusarium* have also been developed (Waalwijk *et al.* 2004), but these require even bigger and more expensive equipment. An alternative molecular technique that can detect DNA targets is Loop-Mediated Isothermal Amplification (LAMP; Notomi *et al.* 2000). LAMP is quicker, requires no thermal cycler and may be executed by people with less training or molecular expertise than necessary for PCR or RT-PCR assays. Another advantage of LAMP assays is that spikelets taken from a field can directly be tested, because the smaller machinery and simpler methods enable the LAMP assays to be practicable on-site. LAMP is a molecular diagnostic method based on the use of DNA polymerase and 4-6 primers. In this presentation we will discuss the design, validation and application of the LAMP assays on wheat spikelets and other wheat and maize samples.

This work is supported by the MycoKey-Project H2020-(E.U.3.2-678781)



*References:*

Demeke, T., Clear, R.M., Patrick, S.K., Gaba, D. 2005. Species-specific PCR-based assays for the detection of *Fusarium* species and a comparison with the whole seed agar plate method and trichothecene analysis. *Int J Food Microbiol*. Volume 103, Issue 3, Pages 271-284.

Notomi, T., Okayama, H., Masubuchi H., Yonekawa T., Watanabe, K., Amino, N., Hase, T. 2000. Loop-mediated isothermal amplification of DNA. *Oxford University Press. Nucleic Acids Research*, 2000, Vol. 28, No. 12.

Waalwijk, C., van de Heide, R., de Vries, I., van der Lee, T., Schoen, C., Costrel-de Corainville, G., Häuser-Hahn, I., Kastelein, P., Köhl, J., Lonnet, P., Demarquet, T., Kema, G.H.J. 2004. Quantitative detection of *Fusarium* species in wheat using Taqman. *European Journal of Plant Pathology*. Volume 110. Pages 481-494

WHO, 1990. International Programme on Chemical Safety (IPCS): Environmental health criteria 105 selected mycotoxins: ochratoxins, trichothecenes, ergot. trichothecenes. (pp. 71–154) Geneva, World Health Organization

## Recent developments in (multi)mycotoxin rapid screening methods

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Mycotoxin analytical methods in food matrices include rapid screening and confirmation techniques. The number of publications covering rapid and sensitive on-site tests suitable for non-laboratory simultaneous determination of several analytes in various matrices is constantly rising. Development of both quantitative (ELISA, FLISA, FPIA, immunosensors) and qualitative (lateral flow, membrane-based flow-through) systems for (multi)mycotoxin detection is one of the fast-growing trends. Developments of various recognition elements as well as novel sensitive labels are currently ongoing in order to design a reliable and rapid test-system.

Natural receptors such as antibodies are most widely used, but also their synthetic analogues and engineered elements can be employed. Working with complicated matrices or designing of a regenerable test-system can only be realized through the use of stable molecularly imprinted polymers (MIPs) or synthetic peptides. Whereas scFv and scAb fragments or aptamers cannot stand an aggressive environment, they provide high specificity, which is important for analysis of structurally-related compounds.

Different labels can be used in immunochemical methods depending on the sample matrix, starting from enzymes (as the most sensitive label) to colloidal gold (widely used). Colloidal semiconductor nanocrystals or quantum dots (QDs) have emerged as a new class of fluorescent labels for biomedical diagnostics, molecular imaging and chemical analysis. The unique optical properties of QDs enable the simultaneous detection of multiple analytes on one single spot provided their conjugates are labeled with QDs which are fluorescent in different parts of the spectrum. Different strategies can be employed for QDs hydrophilization (such as encapsulation with amphiphilic polymer, silica and liposomes) performing different functionalities on the surface and therefore ensuring different conjugation techniques to synthesize QD-labeled immunoreagents.

This presentation will give an insight into current trends and innovations in immunochemical methods for (multi)mycotoxin rapid screening. Examples of rapid tests developed in the frame of the Mycokey EU project will be given.



Session II

Chair Irina Bolat

Boormalt, Belgium



## MycoKey app: an ICT solution to facilitate mitigation of mycotoxin risks

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The MycoKey app is developed as an ICT solution to facilitate mycotoxin risk mitigation by various stakeholders in the food chain. Different work packages of MycoKey generate, validate and integrate knowledge that would provide useful information for risk assessment and will help to raise awareness, alert and specifically notify stakeholders and provide options for mitigation of mycotoxin risks. This knowledge needs to be customized in order to effectively assist stakeholders. The MycoKey app, a mobile accessible platform, will deliver this customized information on a smartphone, tablet or computer. This app will generate a dashboard experience for accessing all relevant information for growers, advisors, grower associations, stakeholders in the production chain as well as policy-makers. It provides information on the risks of mycotoxins and, when required, will suggest management activities to mitigate and reduce the risks. The app is user protected by a personal password and data can be private, shared with colleagues and advisors or anonymized and shared to other stakeholders. Governmental planners and policy makers will have access to shared, public databases and satellite data, as such biomass indices, land-use and mycotoxin risks can be estimated per region. The MycoKey app has different functionalities for smart phone (data entry and retrieval) and computer platforms (data entry and retrieval and analysis). Recalculation using different intervention strategies allows integration of management strategies in the risk model and calculations of “what if” scenarios. We hope to demonstrate the MycoKey app for world-wide mycotoxin risk prediction.

This work is supported by the MycoKey-Project H2020-(E.U.3.2-678781)



# Cropping factors: the key for sustainable mycotoxin management in cereals

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Felix Wettstein<sup>1</sup>, Matias Pasquali<sup>2</sup> and Hans-Rudolf Forrer<sup>1</sup>

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Extensive wheat, barley and oat surveys were conducted to develop recommendations to avoid *Fusarium* head blight and mycotoxin contamination.

For wheat, harvest samples (n=686) and information on cropping measures were collected from Swiss growers (2007-2014). Grains were examined for *Fusarium* species incidence, fungal DNA, the genetic chemotype and mycotoxin content. *Fusarium graminearum* (FG; 65% of all isolated *Fusarium* species) and *F. poae* (FP; 21%) were dominant. Multivariate statistics revealed strong but - depending on the toxins - variable effects of cropping factors. For deoxynivalenol (DON), 11% of all samples exceeded the European limit for unprocessed cereals (1'250 ppb). The combination of pre-crop maize and conservation tillage or ploughing resulted in an average DON content of 2'030 or 310 ppb, respectively, whereas the use of other pre-crops led to average DON contents of 460 and 220 ppb, respectively. Samples from organic farms had considerably lower FG incidence, an effect strongly linked to the high ratio of ploughed fields. The analyses of species incidence, qPCR and chemotype data revealed that nivalenol was produced by FG, FP and/or *F. crookwellense*.

To support cereal growers, the effect of cropping factors was quantified to develop the DON-forecasting system FusaProg. This internet-based system employs plot-specific cropping, growth stage and regional weather data. FusaProg was successfully validated with more than 600 Swiss and German wheat samples.

The barley survey (2013-2014) showed similar patterns as those in wheat, except that tillage did not have a significant effect on the DON content. In oats (2013-2015), T-2/HT-2 toxins were detected in 91% of all samples. Samples of the winter variety 'Wiland' or from fields with pre-crop cereals contained significantly higher T2-/HT-2 contents compared with other varieties or pre-crops.

For growers that depend on a maize-wheat rotation, supplementary strategies are needed for mycotoxin management. The fungal antagonist *Clonostachys rosea* applied during maize harvest onto crop residues appears promising. Currently, different *C. rosea* formulations and strains are examined to ensure competitiveness under field conditions. Inter-/cover crops in



maize-wheat rotations could also reduce FG inoculum through physical barriers or through antifungal properties. Preliminary results from these experiments will be presented.

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## Effectiveness of fungicides against *Aspergillus flavus* and *Fusarium* species

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Cereals can be attacked by several toxigenic fungal species. The so called "Fusarium maize ear rot" disease on maize or "Fusarium Head Blight" on minor cereals (e.g. Barley and Wheat), are caused by several *Fusarium* species, mainly *F. graminearum* Schwäbe that produces deoxynivalenol, and *F. proliferatum* (Matsushima), Nirenberg and *F. verticillioides* (Saccardo) Nirenberg that both produce fumonisins. A pathogen associated to infection of maize kernels is *A. flavus*, an Aflatoxin B1 producing species. Nowadays, according to Integrated Pest Management guidelines, agronomic, genetic and chemical strategies are suggested to reduce fungal and mycotoxins contaminations. However, there is poor knowledge on the fungicides effectiveness to control the diseases caused by the mycotoxigenic fungi. Moreover, in case of maize, only few molecules are registered for maize seed coating and no chemical compounds are registered for spray treatment. In the last years, excellent performances has been shown by Succinate Dehydrogenase inhibitors (SDHI) fungicides against several fungal genera on different crops. SDHIs inhibit fungal respiration by blocking the ubiquinone-binding site of the enzyme succinate-ubiquinone oxido-reductase (SDH, so-called complex II) in the mitochondrial electron transport chain.

Sensitivity of three representative strains for each *Fusarium* and *Aspergillus* species to two SDHIs Boscalid and Isopyrazam was evaluated by colony growth and conidial germination assays. In colony growth test, mycelial disks (4 mm in diameter) were inoculated on three replicated Petri dishes containing Potato Dextrose Agar un-amended (control) or amended with three different concentrations for each fungicide: 500, 50 and 5 mg Kg<sup>-1</sup> and 200, 20 and 2 mg Kg<sup>-1</sup> for Boscalid and Isopyrazam, respectively. The effect of the fungicide on growth was determined by measuring the diameter of developing colonies after 3, 5, 7 and 10 days of incubation at 25±1°C, under an alternating light/darkness cycle of 12 h photoperiod.

In conidial germination assay, aliquots (10 µL) of conidial suspension (1x10<sup>5</sup> conidia mL<sup>-1</sup>) were spotted on disks (6 mm diam) of water agar, such as or amended with fungicides (3 concentrations, as above), placed on sterile microscope slides. The disks were incubated in a moist chamber at 25±1°C, and after 20-24 h, random samples of 100 conidia on each of three replicated spots per condition were observed under a microscope and germinated conidia were counted.

Boscalid was not able to block *Fusarium* mycelial growth after three days (average of inhibition at highest concentration, ranged between 0 and 30%) and after 10 days of incubation it did not affected at all mycelial growth. Isopyrazam showed a higher effectiveness than Boscalid against *Fusarium* up to 10 days of incubation (average of inhibition at highest fungicide quite 100%). Same response was observed in conidial germination test: Boscalid did not block conidial germination at the highest concentration, Isopyrazam block germ tube elongation even at the lowest dose (average of inhibition close to 97%).

*A. flavus* showed a higher sensitivity than *Fusarium* species to both SDHIs up to 10 days of incubation (average of inhibition at lower dose, 100% for Boscalid and more than 80% for Isopyrazam).

Since in many phytopathogenic fungi, mutations in genes encoding succinate dehydrogenase sub-units are responsible for different level of sensitivity to SDHIs, studies are in progress in order to explain molecular mechanisms associated to different sensitivity among fungal genera and the different response of two SDHI fungicides belonging to same chemical group.

## New intervention concepts to avoid storage fungi

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Isothiocyanates (ITCs) are bioactive substances characteristic of the plants of the *Brassicaceae* family. The antifungal activity of the ITCs is due to the strong electrophilic properties of these compounds. They can react easily with nucleophiles such as amines, amino acids, alcohols, water, and sulfites during food treatment and under physiological conditions as well as with several functional groups of many mycotoxins.

The aim of this study was to evaluate the antifungal properties of the bioactive compound allyl isothiocyanate (AITC) against *Penicillium verrucosum* (VTT D-01847) OTA producer on barley.

The experiments were carried out in a system of glass jars containing petri dishes with 10 g of barley contaminated with  $1 \times 10^4$  spores/g of *P. verrucosum*. The cereals were treated by depositing inside the jars and spraying AITC on sterile paper filter at a final concentration of 10 mg/L. Four moisture intervals (13-14, 15-16, 17-19 and 21 % RH) were created in the bottles using different saturated salt levels in order to study the *P. verrucosum* growth and the mycotoxin production as a function of RH and in presence of the AITC. The control group did not receive any treatment. The bottles were closed and kept in darkness at room temperature. During a 4-month test period samples were taken and analyzed: cereal moisture content, residual AITC concentration present in the treated cereal, fungal growth, OTA production and the quantity of AITC present in the head space.

AITC showed a Minimum Inhibitory Concentration (MIC) of 1 ppm and a Minimum Fungicidal Concentration (MFC) of 2 ppm against *P. verrucosum*. The concentration of AITC detected in the headspace ranged from 1 to 0.25 ppm. AITC concentration adsorbed on barley ranged from 0.1 to 0.2 mg/Kg, and the mean reduction of the *P. verrucosum* growth detected in the treated samples in comparison with the controls was of 2 units. In addition, the reduction of OTA production evidenced in the treated cereals was 100%.

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Session III

Chair Susanne Vogelgsang

Agroscope, Switzerland



# Combined intervention strategies to avoid toxigenic fungi – a maltsters perspective

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Barley is the fourth cereal crop in the world in terms of volume produced per year after maize, rice and wheat. Malted barley is the main raw material for brewers and distillers. Infection of the grains by toxigenic fungi is of great concern due to the economic impact as well as the health risk. Among different filamentous fungi species that affect cereals during their growth cycle, *Fusarium* fungi represent the biggest threat for barley and the subsequent malt. The plethora of mycotoxins associated with the plant disease *Fusarium* head blight, highlights the importance of implementing different intervention strategies to avoid or reduce its presence.

The *Fusarium* mould is capable of growing and producing toxic metabolites across the whole barley chain: from the cultivation phase in the field, during improper drying of the harvested grain, at storage due to high moisture and inadequate temperature control as well as during the three steps of the malting process: steeping, germination and kilning.

Maltsters are looking into combined intervention strategies required to tackle the areas of “opportunity” where toxigenic fungi can develop within the process, helping to improve the safety of malt and the beverages produced with it.

Intervention strategies can be implemented throughout the barley production chain commencing with the development and multiplication of barley cultivars with enhanced resistance to fungal infection. Seed treatments are intrinsic in reducing the severity of infection and are the foundation to establishing crops with low level contamination. Biological control agents applied during establishment have been used to reduce the impact of pathogens on yield and quality in some horticultural crops, however, their use prior to the establishment of cereals is very limited or non-existent. The application of BCA's at establishment could be beneficial in ensuring a stable microbial community is present in the soil before the development of pathogens. The application of *Trichoderma* spp. as a seed dressing to reduce spot blotch has been highlighted by Aada and Hack, 2013. However, the important factor is the use of seed with low levels of *Fusarium* spp. contamination as a means of reducing subsequent crop contamination. Furthermore, cultivation methods and position in the crop rotation contribute to the cultural control of fungal disease, as one of the main sources of fungal contamination is the soil that the crop is sown into due to the ever increasing practice of conservation tillage, leaving crop residues at the soil surface. This practice is particularly vexatious as weighing up the requirement for carryover contamination versus financial benefits has moved establishment practices towards more and more direct drill/min tilling, leaving an ever increasing level of infected residue on the surface.



During the growth phase, maintaining a healthy crop canopy through the provision of nutrients and disease control interventions at strategic growth stages is essential in maintaining low level fungal contamination up to harvest. Throughout the growing season the crop (barley, wheat, rye, etc...) is exposed to varying climatic conditions, alternating from dry cold to humid warm conditions and all stages in between. These conditions are suitable to the development of fungal contamination which can cause a reduction in grain yield and quality of the harvested crop. *Fusarium* mould can thrive in crops if suitable weather conditions occur, particularly at the flowering stage of growth. The efficacy of fungicidal active ingredients is likely to contribute to a decreased mycotoxin concentration in grains especially when applied after the milky ripe stage. It is clear that application timing at the flowering stage is important for FHB control.

Mitigation of in storage and process *Fusarium* mould contamination is currently under investigation in the MycoKey project and is very important as a last resort in preventing both mycotoxin development in malt and gushing in the beer produced. Interventions at steeping, whether by biological control agents or other means, can be particularly effective as the level of fungal contamination can and has increased by a 400% during steeping. This is the final stage in which control can be exercised as once the malt is kilned it either contains mycotoxins at or above safe legal levels and must not be used in the food chain or possibly, have gushing potential, which renders the malt unsaleable for beer production.

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# Advanced grain cleaning solutions for mycotoxin reduction

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A value chain approach is needed for an efficient mycotoxin reduction in the food and feed chain, starting from measures to prevent contamination in the field, to control measures to avoid mycotoxin production during storage and over the process line, until final consumption. Grain cleaning is the most effective post-harvest mitigation strategy to reduce high levels of mycotoxins due to the efficient removal of mold-infected grains and grain fractions with high mycotoxin content. Several studies have been performed during the last years to investigate the reduction of deoxynivalenol in wheat and barley, ergot in rye, and total aflatoxins in peanuts and maize.

Typical cleaning steps include

- (i) mechanical size separation and dust removal by aspiration,
- (ii) separation based on density differences, and finally
- (iii) optical sorting. Within grain milling, often a fourth cleaning step is included,
- (iv) "debranning", i.e. removal of the outer layers of the pericarp, and for wet processing as in malting,
- (v) washing can be introduced.

Recently a completely new technology was developed for grain cleaning and monitoring based on the spectral properties of fluorescence. These well proven and recent innovations for mycotoxin reduction will be described further in the talk, taking a whole value chain approach.



## Safe use options of contaminated batches in the metagenomics era

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Mycotoxins represent a risk to the food and feed supply chains with a consistent impact on human and animal health. A high percentage of food and feed batches has been reported to be contaminated with more than one mycotoxin.

Research efforts progressively increase to develop mitigation strategies based on risk monitoring, prevention, intervention, and remediation strategies for multiple mycotoxins contamination.

Since the application of pre- and post-harvest strategies, including physical or chemical removal, are not sufficiently effective, biological transformation is considered the most promising approach to reduce the mycotoxin content. Biological methods consist of the use of microorganisms or enzymes which are able to metabolize toxins into stable, less toxic, up to harmless compounds. In addition, biotechnology enables to obtain massive and less expensive production of enzymes and new engineered biological agents for detoxification in the production process.

The decontamination of heavily contaminated batches is technologically difficult and of great economic impact. In recent years, several alternative application options have been proposed. Among these, the valorization of contaminated batches as input for biofuel production, such as biogas, represents the most attractive and safe option. Complex consortia of microorganisms are responsible for biomass degradation and biogas production. Additionally, during the fermentation steps also mycotoxin degradation has been observed and therefore the exhaust material may be applied as fertilizer. Indeed, deciphering the microbial community and biochemical pathways involved in this process is interesting to study both the anaerobic fermentation and the decontamination process.

Recent advances in sequencing technologies have given rise to deep metagenome-based analyses of complex microbiomes. In this regards, coupling “omic” approaches to the characterization of microbial community acting in a biogas fermenter fed with mycotoxin contaminated batches, will contribute to the previously unprecedented knowledge of decontamination process during biogas production and will provide new insights for the discovery of novel biological agents and enzymes for mycotoxin degradation.

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## Session IV

### Interactive panel discussion

#### Moderators

Max Schulman

MTK & Copa-Copega, Finland  
and

Arja Laitila

VTT, Finland

*Notes*

Session V

Chair Giuseppe Meca

University of Valencia, Spain





# Early process design – how to integrate new actions in practice (modelling and challenges)

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Several physical and chemical post-harvest prevention techniques for mycotoxins exist. These include electromagnetic field, ultrasound or heat treatments, treatments using various biochemicals and chemicals, use of inert gas during storage, and sorting. These all require processing implying costs which, depending on the method, can also be negative.

In quantification of realistic costs and benefits of early stage technologies (TRL 2-4) two aspects need to be considered: 1) the technical and economic performance of the new process, and 2) the impacts of integration. Chemical engineering plant design methods and tools are well suited for such analyses. Conceptual level process design using flowsheet or spreadsheet balance calculations, preliminary economic analyses and sensitivity analyses of the integrated system can reveal possible challenges related to upscaling to commercial scale or utilization of existing equipment and infrastructures including technical equipment scale-up issues, limits in plant/site environmental permits or waste treatment systems, or suitability of existing plant systems. Moreover, the sensitivity of the economic performance on key process and external uncertainties is quantified. These technical and economic results can be used for further concept enhancement, for focusing the technology development efforts such as experimental design and piloting planning, and for business related decision making. This “iterative feedback to technology development” is the most important reason for conceptual process design - systematic, research result based, fast and transparent analysis of alternative parameterizations and implementation scenarios integrated into the actual business context helps with identification of technically and economically non-viable technologies and emphasizing the benefits of technologies.

Key challenge with modelling and simulation based analysis with above mentioned characteristics is formulation of simplified set of equations describing the behavior of mycotoxins and treated grains in the malting and brewing processes. This results partly from the high variability in mycotoxigenic potential among fungal species and strain, and from the lack of detailed models and data for relevant species. Moreover, the (quantification of) possible side-effects of applying different techniques on the grains are not quantified as models and systematic experimental data is lacking. Examples of side-effects are changes in final product quality or processability in actual malting and brewing processes.

In this presentation, the challenges and the strategies to overcome them are further illustrated using case studies from the MycoKey project.

This study has been supported by the EU Project MycoKey N. 678781



# Integrated and innovative MycoKey actions for *Fusarium* mycotoxin management in the malting and brewing chain

Antonio Logrieco<sup>1</sup>, Paola Battilani<sup>2</sup>, Sarah De Saeger<sup>3</sup>, Cees Waalwijk<sup>4</sup>, Theo Van der Lee<sup>4</sup>, Susanne Vogelgsang<sup>5</sup>, Arja Laitila<sup>6</sup>, Michelangelo Pascale<sup>1</sup>, Antonio Moretti<sup>1</sup>, Nunzia Cito<sup>1</sup> and Giuseppina Avantaggiato<sup>1</sup>

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The management of good agricultural practices during pre-harvest is a key issue for minimising the risk of *Fusarium* mycotoxin accumulation in the crops. Such practices involve crop rotation, tillage, appropriate fertilisation and fungicide application, use of biological control agents, variety selection, timely planting and harvests as well as control of insects, which frequently facilitate *Fusarium* species infections. On the other hand, the reduction of *Fusarium* mycotoxins along the malting and brewing chain is also highly dependent on a correct post-harvest and malting management that must firstly aim at the separation of the infected crop products from the healthy material. Therefore, the use of different tools such as manual sorting or optical sensors is also a crucial aspect for reducing the level of mycotoxin contamination. Moreover, it is extremely important to prevent post-harvest contamination and develop practical and effective post-harvest procedures for mycotoxin reduction in the food supply chains and to provide alternative and safe use options for contaminated batches. An updated review will be given on the integrated management of pre- and post-harvest practices aiming at minimising the risk of mycotoxin contamination along the malting and brewing chain and on main effective solutions, including the development of a MycoKey app, proposed and to be achieved within the EU project MycoKey (<http://www.mycokey.eu/>).

This presentation has been supported by the EU Project MycoKey N. 678781



## Speakers, session chairs & panellists



**Mr. Paolo Bazzoli**

*Panellist*

Mr. Paolo Bazzoli is currently working at Anheuser-Busch InBev in GITEC (Global Innovation Technology Center) as Global Malt Specialist, managing the malt pipeline research activities.

He has previous experience in research development as Scientist and Manager at Harboes Bryggeri A/S, Malteroup Group, Martin Braun Gruppe and Diamalteria Italiana.

He finalised his MSc studies in Food Science and Technology at Università degli Studi di Milano in 2005.

Patent RU2015134602A: "The composition of the compound fermented kvass, the method of its preparation and its use in the preparation of drinks".





## Dr. Irina Bolat

### *Session chair*

Dr. Irina Bolat studied Food Science and Technology at the University "Lower Danube" in Galati, Romania specializing in Malting and Brewing. In 2003 she completed her master degree in Food Products Technology and Quality Control. In 2009 she finished her PhD in Industrial Engineering at the same University, with a thesis focused on brewing yeast management. In 2013 Irina finished her second PhD in Industrial Microbiology at the Technical University Delft, the Netherlands, under the supervision of Prof. Dr. Jack Pronk and Dr. Jean-Marc Daran, analysing the hybrid genomes of brewing yeasts. Irina has a vast experience in both brewing and malting, working with Heineken for 9 years and the malting company Boortmalt for the past 4.5 years.

Currently Irina is leading the R&D department of Boortmalt, which is building an Innovation Centre in Antwerp, Belgium. With this project Boortmalt will become the benchmark in innovation in the Malting Industry.





## Tom Bryan

*Speaker and panellist*

Chief Agronomist Tom Bryan qualified with a B.Agr.Sc degree from University College Dublin in 1986, working initially with An Bord Gais, then the Department of Finance assessing the soils of Ireland for agronomic production value and finally moving to Minch Malt in 1988.

Working in the malting industry since 1988 as an agronomist bringing agronomic innovation to life by identifying best practice and facilitating knowledge transfer at farm level to enhance the skills of the growers.

Producing the highest quality malt means that we need a barley agronomy expert who is a stickler for detail and Tom's the man who makes sure that every batch of Minch Malt barley is just as good as the last.

He's our go-to guy for any technical agronomy issues that may affect the consistency of the malt in the early stages of sowing, spraying, harvesting, drying or storage, so if you want to know the minute detail of the growing process, he's your man.

If you'd rather relax with a pint, his is a red ale or, if we're talking whiskey, Scotch is his preferred. His favourite malt is ale malt from good old Taberna barley and he also likes Caramalt malt for the sweet biscuit aroma that it adds to a good craft beer.

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## Sarah De Saeger

*Speaker and panellist*

Prof. Dr. Sarah De Saeger is full professor and head of the Laboratory of Food Analysis, Department of Bioanalysis at Ghent University, Belgium. She is teaching all food-related courses in the Faculty of Pharmaceutical Sciences (Bromatology, Bioanalytical Practical, Special Nutrition). The laboratory of Food Analysis performs in particular research on the issue of mycotoxins on both national and international level. The laboratory focuses on 4 research lines: mycotoxins and human health, detection methods, metabolomics and untargeted analysis, and mycotoxin occurrence. The research covers the characterization (eg. modified mycotoxins), exposure and screening through biomarkers as well as the development of innovative detection methods such as 'molecularly imprinted polymers' and biosensors next, chromatographic and immuno-based techniques. Research results are published in more than 332 publications including 225 peer reviewed papers. Prof. De Saeger is also editor of two books and author of 2 patents. Moreover, she is promotor of 20 defended PhDs.

Prof. De Saeger is coordinating the MYTOX platform as well as the international thematic network (ITN) MYTOX-SOUTH. She is expert in EFSA CONTAM working groups since 2011 and member of the Scientific Committee (SciCom) of the Federal Agency for Food Chain Safety since 2015. In June 2015 she established the Joint Laboratory of Mycotoxin Research of the Ghent University-Shanghai Jiao Tong University-Chinese Academy of Sciences (Shanghai Institutes of Biological Sciences). In 2015 she was awarded the Ghent University Prometheus Award for research and the International DBN Science & Technology Award, registered by the Ministry of Science and Technology, China.



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## Dr. Massimo Ferrara

### *Speaker*

Dr. Massimo Ferrara is research scientist at Institute of Sciences of Food Production (National Research Council), 2013; PhD in Crop Protection, 2011, University of Bari; Master degree in Biotechnology applied to Food and Agriculture Sciences, 2007, University of Bari.

Visiting researcher at Department of Crop Protection, IAS-CSIC, Córdoba (Spain) and at Center for Bioinformatics, University of Tübingen (Germany); Expert advisor for Bayer CropScience and BASF Italia Srl; Member of the International Society for Mycotoxicology; Referee for Analytical and Bioanalytical Chemistry, BioControl, Plant and Soil, BMC Research Notes, International Journal of Food Microbiology, Italian Journal of Food Science, PLOS ONE and Frontiers Journals.

Awarded for the best research article published in 2013-2015 by younger researchers of Department of Biology, Agriculture and Food Sciences (DISBA-CNR).

Involved in several research projects funded by the Italian Ministry of Education, University and Research (CISIA, SAFEMEAT, SAFE&SMART and SIMISA) and by the European Commission (Tirsav Plus and MycoKey).

Key areas of research interest: biology, eco-physiology and phylogeny of toxigenic fungi species; Microbiology and molecular biology of fungi and bacteria; Biological detoxification of mycotoxins; NGS sequencing; Genomics; Transcriptomics; Metagenomics; Computer science; Bioinformatics and database management.





## Dr. Eemeli Hytönen

### *Speaker*

Dr. Eemeli Hytönen is currently working as Business Development Manager at VTT Technical Research Centre of Finland Ltd. Eemeli has a M.Sc. in Applied Physics from University of Jyväskylä (2005), and a PhD in Chemical Engineering from Ecole Polytechnique de Montreal (2011) titled Methodology for Identifying Promising Retrofit Integrated Forest Biorefinery Strategies – Design Decision Making Under Uncertainty. Before business development role Eemeli worked as research team leader of a team focusing on process design, modeling and simulation, sustainability assessment, and recycling and material utilisation in process and manufacturing industrial contexts. He has a broad technological expertise in bio-based industrial processing including pulp and paper, biochemicals, biomaterials, food ingredient and biofuels production. He also has strong methodological expertise in early stage process design, simulation and modelling, process integration, cost evaluation and cost accounting, risk assessment, and decision analysis under uncertainty. Eemeli has authored or coauthored 8 peer-reviewed articles and 26 other publications in process design and simulation context. Eemeli is the chair of the 8th Nordic Wood Biorefinery Conference that will be held in Helsinki in October 2018. Currently his work includes for example managing the development of a commercial process simulation software and enhancing technology upscaling using modern computational methods.



TECHNICAL RESEARCH CENTRE OF FINLAND LTD



## Dr. Marika Jestoi

### *Speaker*

PhD, food chemist Marika Jestoi works as a senior officer at the Finnish Food Safety Authority Evira, responsible for planning and steering of official control on contaminants and radioactive substances in food. Before the current position, Jestoi worked as a senior researcher at the chemistry unit of Evira with a special focus on research of different food contaminants, especially mycotoxins. She is still actively following national research on mycotoxins, e.g. as being member in steering groups of research projects and supervising PhD-studies.





## Dr. Arja Laitila

*Speaker and Moderator*

I am the Principal Investigator at VTT Technical Research Centre of Finland Ltd. in the business area of Solutions for Natural Resources and Environment. My role is to support the whole innovation value chain from research into practical applications in the development of new intelligent concepts for food, beverage and fermentation industry. I hold a PhD in Food Sciences. I have broad experience especially in cereal, malting and brewing research. My particular expertise is in the bioprocessing (with controlled germination of seeds and/or multifunctional microbes) of plant-based raw materials in order to improve safety, structure, flavour and nutritional properties of new beverage and food ingredients. I am also involved in the development of novel means to detect and control microbes in industrial ecosystems.

I have mainly worked in the interface between science and industry (from SMEs to large multinational companies) and successfully acted as a project manager for both large research consortia as well as contract research projects. Furthermore, I am a strong expert in leadership management and have acted as a team leader. I enjoy working with cross-functional teams and across geographical boundaries. I am a member of EBC (European Brewing Convention) Brewing Science Group and Analysis Committee, Microbiology subgroup; and Finnish Cereal Committee (VYR); and the Finnish Master Brewers Association.





## Antonio Logrieco

*Speaker, session chair and panellist*

Director of Institute of Sciences of Food Production, National Research Council of Italy. Scientific responsible and coordinator of various national and international projects dealing on Plant pathology and food safety, with particular attention on mycotoxin problem including the COST action 835 "Agriculturally important toxigenic fungi"; DeTox-Fungi-1999-01380 in the FP V; WP3 "Microsystems Technology solutions for rapid detection of toxigenic fungi and mycotoxins in Good Food FP6-IST-1-508774-IP in FP VI; "Novel integrated strategies for worldwide mycotoxin reduction in food and feed chains"- MycoRed-KBBE-2007-2-5-05 in FP VII; MycoKey; "Integrated and innovative key action for mycotoxin management in the food and feed chain) –MycoKey Horizon 2020. In addition, he has participated in the following EU projects: Wine-Ochra Risk-2000-01761; Ramfic-1999-00284; RAFBCA-2000 01391; Myco-globe-7174.

He is the founder of the Agro-Food Microbial Culture Collection "ITEM". He is the co-founder and former Past-President of International Society for Mycotoxicology and acting President of Mediterranean Phytopathological Union. He was President of ISPP "Fusarium Committee".

Elected as member of Hungarian Academy of Sciences and nominated as Distinguished International Supervisor of Institute of Food Science and Technology, Chinese Academy of Agricultural Sciences. He was member of organizing committee and invited speaker in various international conferences/meetings and referee and editor of various books and international journals.





## Jussi Manninen

*Speaker*

Dr. Jussi Manninen is Executive Vice President at VTT responsible for the business area of Solutions for Natural Resources and Environment. The business area consists of 450 research professionals working in three research areas: Industrial Biotechnology and food solutions, Biomass processing and products, and Sustainable energy and chemical technologies. Jussi moved to VTT from the Ministry of Employment and the Economy of Finland, where he was responsible for the implementation of the Finnish Government's key projects on the Bioeconomy and Cleantech and the Finnish bioeconomy strategy.

Jussi holds a PhD in Process Integration from University of Manchester Institute of Science and Technology (UMIST). Previously Jussi worked at VTT for 15 years in research, development and innovation management in the fields of energy, the forest sector and the bioeconomy.





## Giuseppe Meca

*Speaker and session chair*

Mr. Giuseppe Meca is Associate Professor of Food Science, at the University of Valencia, Department of Preventive Medicine, Faculty of Pharmacy. He got the Master's degree in Food Technology at the University of Naples "Federico II". He has a PhD in Food and Health at the Second University of Naples. He has also PhD in Food Technology at the University of Valencia, where he started the research activity related to the mitigation technologies for the mycotoxin control in food and feed. His formation in this research topic was completed with a fellowship at the Agriculture and Agrifood Canada, where he gained knowledge of the enzymatically and biological techniques for the reduction of the mycotoxins in cereals and derivate products.

He is also a specialist in the analytical techniques for the analysis of the mycotoxins in food and feed using principally the LC-MS/MS. From five years ago his research activity is based on the development of innovative natural solution for the reduction of the mycotoxigenic fungal growth in food and feed. He is author of more than 90 papers published in journals of high impact factors (JCR), and participated to more than 70 congresses at national and international level. He was Principal Investigator in more than 10 projects, some of international relevance. He was also the author of several book chapters related to mycotoxins and mycotoxigenic fungi. He is also the director of the Master Programme in Agrifood Biotechnology of the University of Valencia.

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## Antonio Moretti

*Speaker*

Institute of Sciences of Food Production, National Council of Research ISPA-CNR.

Researcher at the Istituto tossine e micotossine da parassiti vegetali (ITEM, since 2001 Institute of Sciences of Food Production, ISPA), National Council of Research (CNR), since 1989. Senior Researcher at ISPA-CNR since 2007, He is/has been responsible of several National and International projects on Toxigenic fungi. The area of work are Plant Pathology, Mycology, Mycotoxicology and Fungal genetics with main field of interest in the identification, genetic and toxinogenic characterization of main *Fusarium* and *Aspergillus* species, pathogens of agriculturally important crops and the study of their diversity and pathogenicity. He has been responsible for ISPA of several National and European projects on the toxinogenic fungi. He is now Leader of the Work Package 8 "Communication, Dissemination & Exploitation" of the Horizon 2020 EU Project 678781 Integrated and innovative key actions for mycotoxin management in the food and feed chain "MycoKey".

Research activity of Dr. Moretti is well documented by several papers on International Journals and book chapters ISI and hundreds of abstract and proceedings of National and International scientific meetings. H-index of Antonio Moretti: 31 (ISI Web of Science) and 37 (Scopus).





## Sari Peltonen

*Panellist*

Dr. Sari Peltonen is a Senior Specialist in Business development of crop production in Association of ProAgria Centres. She holds a PhD in Plant pathology and has worked for ProAgria since 2000. Before that she has worked as a research associate in the University of Helsinki where she also held a position of acting professor in plant pathology in 1999. In ProAgria she has worked with developing advisory tools for crop production including environmental issues and the EU regulations. She has actively worked in mycotoxin survey of Finnish cereal chain from the year 2000. She has also acted in numerous projects in plant production, plant protection and environmental factors. She has been author or co-author of numerous publications during her career.





## Mareike Reichel

*Speaker*

Mrs. Mareike Reichel manages joint research projects for the development of sampling tools and rapid test systems for mycotoxins at Eurofins WEJ Contaminants, Hamburg, Germany. She has a diploma as Food engineer and does her PhD in postharvest technology at the chair of Plant Foodstuff Technology and Analysis, at Hohenheim University in Stuttgart, Germany. Since joining Eurofins in 2011, she has worked as Research Scientist, Project Manager and Business Unit Manager Development. Beside her work for research and development at Eurofins WEJ Contaminants, she is responsible for worldwide harmonization, standardization, and developments of mycotoxin analytical methods in the Contaminants and Residues Operational Best Practice program of the Eurofins group.





## Max Schulman

*Moderator*

Arable Farmer from Finland and Advisor, Cereals & oil seeds (MTK)

Max grew up on his family's farm which he took over in 1986. Stor-Tötar Gård, is an old farm that combines arable land and forestry in South Western Finland that has been in the family for around 400 years. Continuity that hopefully will go forward since Max is raising three boys together with his Spanish wife Marta.

Before taking over the full responsibility of running the farm and having taken a degree in Agricultural economics, he became a grain trader for the Finnish Grain Board.

After that Max worked in the agricultural machinery sector from 2003 until 2008. This job took him all over the world from America to China.

For the last 9 years, he has been working in the Central Union of Agricultural Producers and Forest Owners (MTK) as the Advisor for cereals, protein crops and oil seeds.

Max is also Chairman of the Cereals Working Group in Copa Cogeca based in Brussels since 2013 and member of the EU Arable Crops Market Observatory.

Part-owner in PolarOats Ltd, which is farmer owned and operated grain trading company.

Co-founder and member of the board of GrainSense Ltd, the portable protein and quality analyzer for grain. Chairman of VYR, the Finnish Grain Chain.





## Paul Schwarz

### *Panellist*

Paul Schwarz is a Professor in the Department of Plant Sciences at, Fargo, ND USA, where he directs malting barley quality research and quality testing for the barley varietal development program. He also serves as the director of the NDSU Institute of Barley and Malt Sciences (IBMS), which is focused on barley and malt education/outreach, as well as the director of NDSU's graduate and undergraduate programs in Food Safety. He has long served as chair/vice-chair of the US Wheat and Barley Scab Initiatives committee on Food Safety and Toxicology.

Dr. Schwarz has a long research interest on the impact of *Fusarium* Head Blight on malt quality, which was initially driven by several severe regional epidemics of FHB that began in the early 1900's. He has previously been employed at Kurth malting (USA), Brauerei A. Egger (Switzerland) and Coors Brewing (USA).





## Katarina Slettengren

*Speaker*

Dr. Katarina Slettengren is working as a Scientific head of the analytics laboratory at Bühler AG. She is an expert on mycotoxin in cereal grains and control measures and she coordinates the MycoKey project from Bühler's side. She works in a customer-facing role, adding value to customer projects by combining expertise in technology and laboratory analytics. She made her PhD at Food Process Engineering, Swiss Federal Institute of Technology Zurich (ETHZ) and her MSc in Biotechnology with specialization in Food and Health at Chalmers University of Technology.





## Theo van der Lee

*Speaker*

Dr. Theodoor Angelo Josef van der Lee has a PhD from Wageningen University (Department of Phytopatology, 2000). He has also studied five years at the Faculty of Biology at the Catholic University of Nijmegen.

He is a senior scientist specializing in molecular phytopathology at Wageningen Plant Research, where he has worked for nearly 20 years. Previously, he worked as a research scientist at the Biotech company Keygene N.V. and was Chairman of the PhD counsel Graduate School Experimental Plant Sciences.





## Susanne Vogelgsang

*Speaker and session chair*

Dr. Susanne Vogelgsang obtained a Diploma in Agrobiology (Plant Protection, Physiology, Ecology, Horticulture) from University of Hohenheim, Germany in 1994 and a PhD in Plant Science (Weed Biology/Plant Pathology) from McGill University, Canada in 1998. Between 1998-1999, she was a postdoctoral fellow at the University of Fribourg (Switzerland) and between 2000-2001 a visiting scientist at the Pacific Forestry Centre, in British Columbia, Canada. Between 2001 and 2003 she worked as a Technology Transfer Officer for the NCCR Plant Survival in Neuchâtel (Switzerland).

At Agroscope in Zurich (Switzerland) she is head of the research group "Ecological Plant Protection in Arable Crops". She also coordinates the Swiss Mycotoxin Research & Extension Network.

Her major professional interests are:

- the development of sustainable cropping systems to control plant diseases in arable crops
- the utilisation of surveys and forecasting systems to develop strategies to avoid pests and diseases
- biological control and use of botanicals or thermal treatments to limit plant diseases in cereals and potatoes







## Practical information of Finland and Helsinki

Here we collected some practical information that maybe useful during your visit.



Finland is a country of forests and lakes. In Finland lakes and rivers make up 10% of the country. The large areas of forest cover almost two thirds of the land mass. Only 6% of Finland is arable. It is one of the Nordic countries and bordering Sweden, Norway and Russia. Area wise the country is the fifth largest in Europe (338,424 km<sup>2</sup>) with only 5.5 million inhabitants. It is the most sparsely populated country in the European Union, with only 16 inhabitants per km<sup>2</sup>. There are four seasons in Finland winters being cold and summers warm.

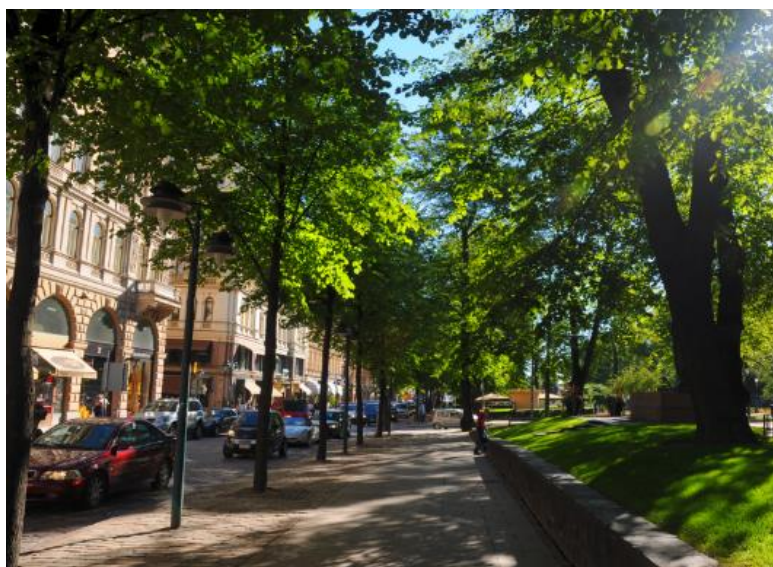
Finland is a republic and is an independent country since 1917. It became a member of the European Union in 1995 and part of the European Monetary Union in 2002 and the only Nordic country using the Euro as currency. Finland was the third country in the world and the first one in Europe allowing women to vote. This happened as early as 1906. The electronics, machinery, forestry, high-tech and design industries are Finland's most important revenue sources.

Finnish language is a non-Indo-European language belonging to the Uralic family, along with Estonian and Hungarian. However, language is not a problem. As most Finns take it for granted that you do not speak their language, they are glad to make use of their English or other European languages they master. Finland is in fact a bilingual country, the second official language being Swedish.

### Climate and weather

Helsinki's climate combines characteristics of both a maritime and a continental climate. The proximity of the Arctic Ocean and the North Atlantic creates cold weather, while the Gulf Stream brings in warmer air.

Spring arrives in Helsinki usually sometime in April. The days grow rapidly longer and warmer, attracting people to the city while the nature blossoms all around.



Summer in Helsinki is bright. Days are at their longest in the second half of June, when the sun stays above the horizon for 19 hours.

Average temperatures in Helsinki

- ▶ Entire year: +5.9°C
- ▶ Warmest month: July +17,8°C
- ▶ Coldest month: February -4,7°C

For the latest weather forecast, see website [en.ilmatieteenlaitos.fi](http://en.ilmatieteenlaitos.fi) by the Finnish Meteorological Institute.



### City bikes

The City of Helsinki is attempting to increase levels of cycling in city traffic. The city bike system supports this goal. During city bike season 2018 there will be 1,500 bikes and 150 bike stations in Helsinki.

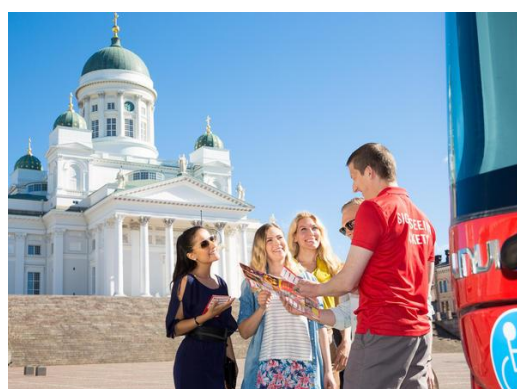
### City sightseeings in Helsinki

*Boat tour in Helsinki archipelago.* Enjoy a guided sightseeing tour by boat and experience the beautiful archipelago and canals of Helsinki. The tour passes the maritime highlights of the capital.

*Guided tours & Hop On Hop Off in Helsinki.* Explore the city on a guided sightseeing tour by bus and see all the top sights of Helsinki! Take a tour with Hop On Hop Off or enjoy a city tour with Helsinki Panorama.

*Sightseeing by bus and boat in Helsinki:* Enjoy Helsinki by bus and boat with our combination tickets. Two guided sightseeing tours that let you discover the main sights in the capital both from land and sea.

More information: [www.stromma.fi/en/helsinki/](http://www.stromma.fi/en/helsinki/)





### How to eat seasonal food in Helsinki

Finns are passionate about their food and they know how to celebrate it. Finns are also fiercely loyal to their culinary roots. Finland is full of interesting contrasts, such as the four seasons, the Midnight Sun and winter darkness, urban and rural, East and West. Go on and try, don't be shy.

Read more at:  
[www.myhelsinki.fi/en/eat-and-drink/restaurants](http://www.myhelsinki.fi/en/eat-and-drink/restaurants)

### Currency and payments



The local currency in Finland is Euro (EUR). All major credit cards are widely accepted in Finland. For an ATM machine, look for the sign "OTTO". These 24-hour cashpoint machines are widely available and accept the following international ATM and credit cards: Visa, Visa Electron, EuroCard, MasterCard, Maestro, Cirrus and EC.



Banks are usually open on weekdays 10am–4:30pm. In addition to banks, there are several foreign currency exchange points available around the city center. See for example: Forex: Stockmann Department Store or Central Railway Station & Tavex: Fabianinkatu 12.

### Electricity

Voltage: 220–240 Volts. Electrical sockets (outlets) in Finland are one of the two European standard electrical socket types: "Type C" Europlug and "Type E/F" Schuko.

### Emergency number

General Emergency number for police, ambulance and fire department is 112.



### Postal services

Post offices are open 9am–6pm (some offices even until 8pm) from Monday to Friday. Yellow mailboxes are available for collections on weekdays.



Stamps can be purchased at post offices, bookstores, newsagents, kiosks and hotels.

Helsinki General Post Office is located at the center of Helsinki, Elielinaukio 2 F.



### Tax free shopping

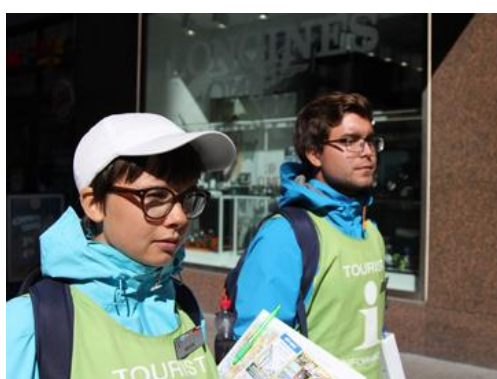
Citizens of non-European countries are eligible for tax-free returns upon leaving EU territory. Purchases must be made in shops displaying the Tax Free Shopping sign. The minimum total sum of purchased goods must be 40€.

### Time zone

The time zone in Helsinki is Eastern European Time (EET), 2 hours ahead of Greenwich Mean Time (GMT+2).

### Tipping

Tipping is not expected in Finland and a service charge is added in hotels and restaurants. Finnish people do tip (max 10%) only if they wish to appreciate good service or delicious food. It is not common to give a tip to the taxi drivers.



### Tourist information

Helsinki Tourist Information ([www.myhelsinki.fi](http://www.myhelsinki.fi)) offers free information about the city, sights, events and services including a wide range of brochures and maps all year round.

From May 2018, tourist information services will be available at the Central Railway Station, inside Stockmann's department store and at Helsinki Airport.

In summertime, visitors to Helsinki are also served on the streets of the city by the Helsinki Helpers in their easily identifiable green jackets. In addition, tourist information will be available in the historic center of Helsinki during the summer season at the Info Container by the Market Square.

### WiFi

You can connect your laptop or mobile phone to a wireless network in many places throughout the city center e.g. in several cafes, restaurants and libraries.

For free WiFi, connect to "Helsinki City Open Wlan". There are plenty of hotspots available in the city center and at harbors. In addition, most hotels offer their guests a free internet connection. For the international research and education community, it is also possible to use Eduroam service while in Helsinki.

